WARD

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COMPLETE SPECIFICATION

Improvements in or relating to Fluid Dispensing Devices

I, LAWRENCE THOMAS WARD, of Riverside Terrace, Portland, Penna., United States of America, a Citizen of the United States of America, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to fluid dispensing devices and is more particularly concerned with the construction of dispensing valves for controlling the discharge of a fluid substance which comprises a pressure-generating medium from within a pressure-tight container. The term "fluid substance" is intended to include not only substances which are in the gaseous or liquid state but also substances having a paste or cream-like consistency such as whipped cream, shaving cream and the like. Control valve arrangements according to the invention are especially suitable for the marketing and dispensing of a wide range of commodities such as insecticides, germicides, cosmetics, medicines, drugs and so on with which are incorporated a suitable quantity of low boiling point liquid propellant such as the gas known under the Registered Trade Mark "Freon".

One object of the invention is to provide an improved dispensing valve construction which is adapted to deliver a definite or metered amount of the required substance at each operation of the control valve. Such metered quantity facility is particularly advantageous in many instances. Thus it provides for the economical and convenient dispensing of products such as shaving cream, tooth paste and the like where only a relatively small and more or less predetermined amount is normally required at each instance but an even more important application of such metered quantity facility is in the dispensing of medicinal substances such as drugs, medicines and therapeutic or prophylactic materials where it is often highly desirable or even essential to limit the amount made available upon operation of the dispensing valve so as to avoid the possibility of undesirable effects due to the discharge of an excessive quantity owing to careless or inexperienced operation by a user. With such a metered quantity facility it is possible to issue, with the container, explicit instructions regarding the desirable or maximum dosage for the marketed substance within the container with an assurance that such dosage cannot accidentally be exceeded.

Another object of the invention is to provide improved and simplified valve constructions affording such metered discharge facility and which are capable of convenient and cheap manufacture.

Other objects of the invention reside in the provision of a valve structure which is capable of being made of conveniently small size for incorporation in miniature dispensing container devices such as perfume dispensers for accommodation within a lady's handbag.

Yet a further object of the invention is to provide a metered valve construction by which a spray form of discharge is provided and in which such spray is of substantially uniform substance concentration over the entire spraying period.

In accordance with the broadest aspect of the invention a fluid dispensing device for dispensing at each operation thereof, a predetermined metered quantity of a fluid substance from a pressure-tight container which contains a pressure generating medium therein, comprises a reservoir chamber for holding said predetermined quantity of fluid substance, a reciprocatory rod-like plunger having a tubular upper section, a central section disposed within said reservoir chamber and a lower section, a resilient ring surrounding said upper section of said plunger and adapted hermetically to seal such upper plunger section to the upper end of said reservoir chamber, a lateral outlet port from the bore to the exterior of said tubular upper section of said plunger, said outlet port being

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arranged to coact with said resilient ring to form a first valve which becomes closed when said plunger is raised and which becomes opened to provide access from said reservoir chamber to said bore of said tubular upper section of said plunger when the latter is lowered and an inlet port leading to said reservoir chamber, said inlet port being arranged to coact with the lower section of said plunger to form a second valve which becomes opened when the plunger is raised and which, upon lowering of said plunger, becomes closed to liquid flow therethrough before said first valve is opened.

The above and further objects and features of the invention will be more readily understood from the following detailed description of a number of different embodiments given by way of example and with reference to the accompanying drawings in which:—

Fig. 1 is a longitudinal sectional view through a pressure-tight container incorporating a dispensing valve structure in accordance with the present invention.

Fig. 2 is an enlarged vertical cross-sectional view of one form of valve structure in accordance with the invention, the valve operating member being shown in its normal or first position whereby the reservoir chamber becomes charged with the substance to be dispensed.

Fig. 3 is a view similar to Fig. 2 but with the valve operating member shown in its opposite or second position where discharge of the metered quantity of substance from the reservoir chamber can take place.

Fig. 4 is a fragmentary view showing a modification of the arrangement of Figs. 2 and 3.

Fig. 5 is a further fragmentary view showing a modified form of the valve operating member.

Fig. 6 is a vertical cross-sectional view of a further modified form of valve construction, the valve operating member being again shown in its first position where the reservoir is conditioned to be charged with the substance to be dispensed.

Fig. 7 is a view similar to Fig. 6 but showing a modified reservoir chamber formation and with the valve operating member in its opposite or second position where such reservoir is in communication with the discharge orifice.

Fig. 8 is a fragmentary view showing a modified construction of the valve closure member for the embodiment of Fig. 7.

Figs. 9, 10 and 11 are vertical cross-sectional views through a further modification in accordance with the invention, the valve operating member being shown in its first position in Fig. 9 and in its second position in Fig. 11 and in a position intermediate said first and second positions in Fig. 10.

Fig. 12 shows a modified form of the arrangement shown in Figs. 9, 10 and 11.

Fig. 13 shows another modified form of the arrangement shown in Figs. 9, 10 and 11.

Figs. 14 and 15 show another modified construction in accordance with the invention, the valve operating member being illustrated in its first and second positions respectively in the two figures.

Fig. 16 is an external view, partly in section, of an alternative arrangement according to the invention.

Fig. 17 is an enlarged fragmentary cross-sectional view of the structure shown in Fig. 16.

Fig. 18 is a fragmentary transverse cross-sectional view taken on the line 18—18 of Fig. 17.

Figs. 19 and 20 are vertical cross-sectional views of yet a further modified valve construction according to the invention, the valve operating member being shown respectively in its first and second positions in the two figures.

Fig. 21 is a sectional view showing a modified form of part of the valve structure shown in Figs. 19 and 20.

Fig. 22 is a fragmentary view of a further modified form of the lower end of the valve operating member of Figs. 19 and 20 or 21.

Fig. 1 shows, in vertical cross-section, a typical example of a dispensing device with which a valve structure in accordance with the present invention is designed to co-operate. The illustrated example is a perfume spray dispenser and comprises a container 10 of conventional construction for retaining a quantity of low boiling point liquid substance 11 under pressure, for example, that known under the Registered Trade Mark "Freon" or other pressure-generating medium having a small amount of perfume dissolved or dispersed therein. The container 10 is provided with a screw-threaded aperture 12 at its upper end. This aperture is adapted to receive the correspondingly screw-threaded neck 13 of a valve body 14. A supply or dip tube 15 extends from the valve body downwardly into the liquid substance 11 while, on the outside of the container, an outwardly projecting portion of a valve operating member 16 has secured thereto an operating knob 17 in the form of a finger pressure plate and provided with an internal discharge conduit 18 terminating in a spray discharge orifice 19.

Referring now more particularly to Figs. 2 and 3 the valve body 14 is provided with a main bore 20 in which is disposed the valve operating member 16 in the form of a plunger having a central section 21 which is a relatively loose fit within the bore 20, an upper section or stem 22 of reduced diameter extending outwardly beyond the upper end of the valve body and a dependent lower section 23 of still further reduced diameter

directed towards the closed bottom end of the main bore 20. The upper section 22 is provided with an axially disposed conduit 24 extending from its uppermost end towards the central section 21 and a lateral port 25 communciates between the bottom end of such conduit 24 and the exterior of the said stem 22.

The stem 22 is in sealing but slidable engagement with the bore of a resilient sealing ring 26 located within a counter-bore 27 from the upper end of the valve body, such sealing ring being retained in position by a ring 28 disposed in a further counter-bore 29 and held in position by means of peened - over lugs 30 extending inwardly from the main portion of the valve body. The shoulder surface 31 formed at the junction of the two different diameter sections 21 and 22 of the valve operating member 16 is adapted to enter into seating and sealing engagement with the underside of the sealing ring 26.

The reduced diameter lower section 23 of the valve operating member 16 is surrounded by a resilient ring 32 held in position by a rigid retainer ring 33 embracing the lower end of the section 23, such retainer ring being held in position by the action of a helical compression spring 34 held trapped between the underside of such ring and the bottom of a reduced diameter extension bore 35 of the main bore 20. The spring 34 operates continuously to urge the valve operating member 16 resiliently upwards to the normal or first position thereof as shown in Fig. 2.

An axially directed conduit 36 extends upwardly from the lowermost end of the lower section 23 to a point near the middle of the central section 21 of the valve operating member where such conduit is in communication by way of one or more radial ports 37 with the exterior of the said central section.

The valve body 14 is provided with an enlarged outer collar 38 at its upper end above the screw-threaded neck 13 while below such neck the body is reduced in diameter to form a region 39 separated from a still further reduced diameter region 40 by an intermediate annular projecting rib 41. The dip tube 15 is adapted to fit over and embrace tightly the region 39 and the annular rib 41 whilst leaving an annular passageway 42 between the inner surface of the dip tube and the outer surface of the region 40 of the valve body for the passage therethrough of the liquid substance 11 in the dip tube 15 to a transverse port 43 communicating with the main bore 20.

In the operation of the spray valve construction just described, the normal or first position of the valve operating member 16 is that shown in Fig. 2 whereby the internal pressure within the container 10 causes the substance 11 to pass by way of the dip tube 15 through the inlet orifice constituted by port 43 and thereby to fill the lower end of the main bore 20 and its extension 35, the conduit 36 and the annular space surrounding the central section 21 of the valve operating member by way of ports 37. The spring 34 continuously urges the valve operating member 16 upwardly to provide sealing engagement between shoulder 31 and sealing ring 26.

Downward movement of the valve operating member 16, e.g. by manual depression of the stem 22 by pressure on the operating knob 17 (Fig. 1), from the first position shown in Fig. 2 to the second position shown in Fig. 3 causes, firstly, the closure of the first valve means constituted by the inlet port 43 and ring 32 by the passage of the sealing ring 32 over such port thereby cutting off communication between the main body of the liquid substance 11 in the container and the interior of the reservoir chamber formed by the unoccupied regions of the bores 20 and 35 and the communicating conduit 36 and ports 37. The continued downward movement of the valve operating member later causes the opening of second valve means constituted by the port 25 and sealing ring 26 by the movement of such port through the bore of the sealing ring 26 to the position shown in Fig. 3 where such port 25 is in communication with the main bore 20. This allows fluid communication and the resultant outward flow, under the self-generated pressure, of the liquid substance previously trapped in the reservoir chamber through the port 25 and the outlet orifice of the valve constituted by the conduit 24 and so to the discharge orifice 19 in the operating knob 17 (Fig. 1).

The quantity of substance delivered upon one operation of the knob 17 is thus determined by the volumetric capacity of the aforesaid reservoir chamber and when this quantity of substance has been dispensed under its self-generated pressure, the discharge ceases automatically and cannot recur until the valve operating member 16 is again caused to move to its original or first position shown in Fig. 2. During such return movement the upward displacement of port 25 through the sealing ring 28 causes closure of the second valve means constituted thereby and this is followed, later, by the opening of the first valve means due to the unmasking of port 43 by the uprising lower edge of the sealing ring 32. The reservoir chamber can then refill with the substance 11 from within the container 10 in readiness for a repetition of the operation cycle at the next operation of the valve operating member 16.

In this embodiment the valve body 14 and the valve operating member 16 are conveniently of metal although other rigid materials may be used. The sealing ring 26 and the ring 32 are of resilient material such as

rubber or a suitable plastic material. The dip tube 15 is conveniently of plastic material also.

The embodiment shown in Fig. 4 is generally similar to that described in connection with Figs. 2 and 3 except for a modified formation of the upper sealing ring 26 and its retaining means. In this embodiment the sealing ring 26*a* is of quadrant shape in cross-section and is held within the turned- or spun-over apertured dome 45 formed from an integral flange on the upper collar 38 of the valve body 14.

Fig. 5 shows an alternative formation for the first or inlet valve means on the valve operating member 16. In this example the spring 34 is adapted to seat upon the lower end of the rigid valve plunger 16 and the resilient sealing ring 32 is replaced by two separate smaller sealing rings 32*a* each disposed within an individual annular groove 47 formed in the lower section 23 of the valve operating member. The operation of this embodiment is simliar to that already described, the cutting off of communication between the reservoir and the dip tube 15 being effected by the passage of the lower ring 32*a* over the port 43.

Fig. 6 shows a further modification in which the bottom section of the valve operating member or plunger 16 is solid and the reservoir chamber is of annular form surrounding the plunger while the spring means for urging the member 16 into its first or normal position is disposed externally of the valve body 14. In this embodiment the bottom section 48 of the plunger is formed with an annular bulbous terminal region 49 which slides within and is in sealing engagement with the upper end of the dip tube 15. The valve body 14 is provided with a dependent body wall 50 defining a cylindrical chamber 51 which is constricted at its lower end by a reduced diameter region 52 whose inner bore is slightly smaller than the outer diameter of the dip tube 15 whereby a liquid-tight seal is provided between such constricted region and the outer surface of the dip tube. The dip tube is provided with a transverse port 43*a* leading from its bore to the chamber 51 at a point which is just below the bulbous end 49 of the plunger 16 when the latter is in its first or normal position as shown.

The sealing ring 26*a* surrounding the stem 22 of the plunger is housed in an upwardly directed counterbore in the body 14 within which is also located the uppermost end of the dip tube 15. The stem 22 is provided with an axial bore 24 as in the previous embodiments and a transverse port 25 which provides communication between such bore 24 and the chamber 51 by way of transverse port 43*a* and the inner bore of the dip tube 15 above the bulbous 49 of the valve plunger when the latter is moved downwardly to its second or discharge position.

The operating knob 17 is secured upon the upper end of stem 22 through the intermediary of a resilient sealing ring 53 and a conventional retaining ring 54 press-fitted into an annular groove in the plunger stem, both parts being held within a counterbore in the underside of the operating knob. A helical spring 34*a* surrounding the stem 22 and trapped between the underside of the knob 17 and the upper surface of collar 38 of the valve body serves to urge the valve plunger resiliently outwards.

The operation of this embodiment is generally similar to that of the previous embodiments. With the parts in the position shown the reservoir chamber 51 is in fluid communication through port 43*a* with the interior of the dip tube 15 and hence with the substance within the container; the reservoir chamber 51 is accordingly filled with such substance. Upon downward movement of the plunger 16 against the action of spring 34*a*, the bulbous region 49 passes over port 43*a* to cut off communication between the reservoir chamber 51 and the main body of dispensible substance within the container and thereafter to establish communication between such chamber 51 and the annular space between the bore of the dip tube 15 and the outer surface of the lower section 48 of the plunger 16 lying above the region 49. After further downward movement of the plunger 16, the port 25 becomes uncovered below the lowermost surface of the sealing ring 26*a* and fluid communication is established between the reservoir chamber 51 and the discharge orifice by way of port 43*a*, port 25 and bore 24 to allow the metered contents of the reservoir chamber to be discharged.

Fig. 7 shows a further modification which is generally similar to that of Fig. 6 but wherein the form of the lower end of the valve body 14 is simplified by making such body with a single diameter counterbore 55 extending upwardly from its lowermost end. Within this counterbore is received a tubular insert 56 of resilient material, such as rubber or plastic, such tubular insert having an annular region of reduced diameter intermediate its ends to provide an annular reservoir chamber 57. The insert also has an inner bore 58 for receiving the lower section 48 of the valve operating member or plunger 16, which section has a bulbous terminal region 49 as in Fig. 6. At its upper end the inner bore of the tubular insert is of reduced diameter to enter into sealing engagement with the stem 22 of the valve operating member and so to form the equivalent of the sealing ring 26*a* of Fig. 6. The insert 56 is held within the counterbore 55 by turning over the lower edge of the valve body as shown at 60 while the dip tube 15 is a force fit in the

lower end of the inner bore 58.

The operation of this embodiment is similar to that of Fig. 6, the annular reservoir chamber 57 being normally in communication with the main body of the dispensible substance within the container 10 through the dip tube 15 and port 43*a* when the plunger 16 is in its raised position opposite to that shown. Upon downward movement of the plunger 16 against the action of spring 34*a* towards the position shown in Fig. 7, the port 43*a* is first passed over by the bulbous region 49 to cut off communication between the chamber 57 and the interior of the container 10 and thereafter to establish communication between the chamber 57 and the annular region within the bore 58 surrounding the lower section 48 of the plunger; continued lowering of the plunger 16 then causes port 25 to fall below the end surface 59 at the upper end of the insert to establish communication between the annular reservoir chamber 57 and the discharge orifice 19.

The bottom section of the plunger of Figs. 6 and 7 need not be of the solid bulbous ended shape as shown but may be modified in the manner illustrated in Fig. 8. In this modification the whole of the bottom section of the valve operating member or plunger 16 is of lesser diameter than the inner bore of the dip tube (Fig. 6) or of the tubular insert 56 (Fig. 7) as the case may be and is provided with a resilient sealing ring 62 held within a groove 63 of suitable, e.g. rectangular, cross-section. With such a modification of the arrangement of Fig. 6, both the plunger 16 and the dip tube 15 may be made of rigid material such as metal or glass.

Figs. 9, 10 and 11 illustrate a further modification of the invention particularly adapted for use in the dispensing of substances, such as perfumes or medicinal products mixed with a suitable low boiling propellant or solvent, with a view to ensuring complete discharge of the metered quantity of substance and to preventing separation of the perfume from the liquid propellant with consequent change of concentration strength during the evacuation of the reservoir chamber in the course of discharge.

In this embodiment the valve actuating member or plunger 16 has a central section 21 of largest diameter which is a loose fit within the bore 65 of the valve body 14, an upper section or stem 22 having an axial bore 24 directed inwardly from its uppermost end and provided with a transverse port 25 similar to the earlier embodiments and a lower section 23 which is formed of a plurality, e.g. three, united coaxial cylinders of progressively diminishing diameter. The uppermost cylinder 66 integral with the central section 21 is of a diameter larger than the bore of an insert or collar 69 held in the lower end of the bore 65 whereas the next lower or mid cylinder 67 of the lower section is of a diameter so very slightly less than the bore diameter of said collar 69 that the passage of gas or vapour but not of liquid is permitted when it is positioned in such bore; the lowermost and terminal cylinder 68 is of a diameter appreciably less than that of the bore of said collar. The junction regions between the adjacent cylinders are of truncated conical form as shown while the upper edge of the bore in the collar 69 is rounded as shown to act as a valve seating for co-operation with the conical surfaces between cylinders 66 and 67.

The collar 69 which is either connected to or may be made integral with the dip tube 15 is held within the lower end of the bore 65 by resting upon an inwardly directed shoulder 70 formed around the lower end of the valve body. A helical spring 34 is trapped between the underside of the central section 21 of the plunger 16 and a pressure ring 71 resting upon the upper surface of the collar 69 whereby the valve operating member or plunger 16 is normally urged upwardly to bring the annular surface formed by the shoulder 31 between the central and upper sections thereof in sealing engagement with the underside of a quadrant section sealing ring 26*a* of resilient material which is held in position by the turned- or spun-over dome 45 made integral with the upper collar 38 of the valve body 14.

In the operation of this embodiment, the normal or first position of the valve operating member 16 is that shown in Fig. 9 where the reservoir chamber constituted by the space within the bore 65 of the valve body 14 above the collar 69 becomes filled with the substance to be dispensed through the dip tube 15 and the bore of the collar 69 and the passage between such bore and the surface of the lowermost cylinder 68. Upon actuation of the valve operating member or plunger 16 to effect discharge such member is lowered first to a position such as that shown in Fig. 10 where the entry of the mid cylinder 67 within the bore of the collar 69 causes complete cut-off of any liquid communication between the interior of the container and the reservoir chamber while still permitting the passage of propellant gas or vapour. At a point similar to that also shown in Fig. 10 the port 25 in the upper section 22 of the valve operating member 16 becomes uncovered by its downward movement past the lower surface of the sealing ring 26*a* whereby the reservoir chamber is placed in communication with the bore 24 of the stem 22 of the valve operating member and hence with the discharge orifice of the operating knob (not shown) arranged as in the earlier embodiments. The contents of the reservoir chamber are accordingly released and the self-expulsion of the whole of the metered quantity of substance previously

trapped therein is assisted by the continued supply of pressure gas or vapour through the narrow annular gap between the cylinder 67 and the bore of the collar 69. The incoming gas or vapour serves to sweep the reservoir chamber clear of the metered substance and thereby avoids any inadvertent retention of a residue of the less volatile element of the mixture such as perfume which may otherwise become separated from the propellant upon the decrease of pressure within the reservoir chamber which occurs when the discharge path is opened in the embodiments previously described. The continued downward movement of the valve operating member 16 finally brings the truncated-conical junction surface between the cylinders 66 and 67 into seating engagement with the upper end of the collar 69 thereby completely cutting off the reservoir chamber from either gas or liquid communication with the interior of the main container. The position shown in Fig. 11 is the final or second position of the valve operating member and the discharge of the metered quantity is thereby completed and terminated until the release of the valve operating member for return to the position shown in Fig. 9 when the reservoir chamber can again be refilled from the main body of substance held in the main container.

The embodiment of Figs. 9, 10 and 11 is shown with an externally screw-threaded region 13 on the valve body 14 for entry into a correspondingly threaded aperture of the main container 10 (Fig. 1) but alternative fixing arrangements may be employed either with this embodiment or with the earlier embodiments.

One alternative arrangement is shown in Fig. 12 in which the valve body 14 is formed with an outer collar 38 of circular profile for reception within a counterbored region 73 of the reduced diameter neck 74 of a container 10 together with a resilient sealing washer 75 interposed between the underside of said collar 38 and the end surface of the counterbore, the parts being finally secured in position by turning-over the edge of the container to form a beak or hawknosed region 76 entering into engagement with the upper surface of the collar 38.

A further alternative along similar lines is shown in Fig. 13 where the valve body 14 and the collar 69 (Figs. 9—11) whose bore operates with the lower section of the valve operating member 16 are combined as a one-piece member 14*a* which is further enlarged at its uppermost end and counterbored from its outer side as shown at 78 to receive a sealing ring 26*b* for co-operation with the stem 22 and the upper ledge surface of the central section 21 of the valve operating member as in the previous embodiments of Figs. 9—11 and Fig. 12. The sealing ring is held captive in the required position by the provision of a rolled-over flanged member 79 which surrounds the largest diameter portion of the valve body and is provided with an inturned lip engaging on the under surface of such largest diameter portion and with an inwardly directed upper flange terminating in a central axially projecting collar 80 surrounding the stem 22 of the valve operating member. This integral unit is then disposed within a counterbored region 73*a* of the neck 74 of the container 10 with a sealing washer 81 of compressible material surrounding the collar 80, the terminal edge of the container neck being subsequently turned-over inwardly as shown at 82 to compress the sealing ring 81 and to effect a sealed engagement of the valve structure within the container neck.

In the embodiment of Figs. 12 and 13 the dip tube 15 is shown as a separate element in sealing engagement with the bore of the collar 69 (Fig. 12) or of the equivalent integral portion at the lower end of the valve body 14*a* (Fig. 13) but such dip tube may, if desired, be made integral with the collar or with the valve body.

The collar 69 and the dip tube 15 may be made of plastic material and the valve body 14 and plunger 16 of metal such as brass or, more preferably, of aluminium where perfumes are to be dispensed. In some cases, however, particularly where drugs and other materials which must be free from metal contamination are to be dispensed, the container 10, the dip tube 15, the valve body 14 and the plunger 16 may all be of glass or plastic or optionally or selectively of stainless steel or other corrosion resistant metal.

Figs. 14 and 15 show a further embodiment of the invention particularly adapted for use with substances such as medicinal products and the like where possible contamination by contact with metal surfaces is to be avoided.

This embodiment is particularly adapted for association with a container 10 of glass and as shown the valve assembly is secured in position upon the neck of such glass container by means of a rolled-over metal cap 84. The valve structure generally comprises a valve body 14 having a top collar 38 adapted to seat upon the upper surface of the bottle neck and a dependent tubular portion defining a cylindrical reservoir chamber 51 terminated by a constricted throat region 85 leading to a reduced diameter lowermost portion 86 in which is provided a tubular cavity for receiving the dip tube 15. The outer surface of such tubular portion is provided with a plurality of projecting ribs 87 which enter into sealing engagement with the inner surface of the bottle neck aperture.

The valve operating member or plunger 16 has a stem 22 projecting outwardly through a resilient sealing ring 26*b* located in a counterbore in the upper surface of the valve body

and is also provided, as in the earlier embodiments with a central section 21 located in and in loose fitting engagement with the reservoir chamber 51. A helical spring 34 trapped between the underside of such central section 21 and the shoulder formed between the bottom of the reservoir chamber 51 and the throat region 85 serves to urge such valve operating member upwards to bring the upper surface of said central section into sealing engagement with the sealing ring 26*b*. Such sealing ring 26*b* is held in position by the same rolled-over cap 84 as serves to secure the valve assembly on the bottle neck. The cap 84 is provided at its centre with an outwardly projecting tubular flange which embraces the stem 22 of the plunger 16, such stem having an axial bore 24 directed inwardly from its upper end to a point below a radial transverse port 24 leading to the outside of such upper section as in the earlier embodiments.

The valve operating member or plunger 16 comprises a lower section 23 of further reduced diameter terminating in a frusto-conical end region 88 which is arranged to co-operate with the constricted throat 85. The constricted throat 85 is provided with a rounded contour as shown and co-operates with the lower section 23 of the valve operating member 16 whereby such lower section can pass through the aperture of the throat but with the walls of said throat aperture entering into sealing engagement with the outer surface of the said lower section so as to close the inlet orifice from the dip tube 15.

The operation of this embodiment is generally similar to that of the embodiments already described with reference to Figs. 2—8, the valve operating member 16, when in its first or normal position as shown in Fig. 14, providing a fluid connection between the dip tube 15 and the reservoir chamber 51 through the now-open throat 85 whereby the latter becomes filled with a quantity of the substance to be dispensed. At this time the engagement between the upper surface of the central section 21 of the valve operating member with the under surface of the sealing ring 26*b* provides complete sealing against any outward discharge from the reservoir chamber. Upon depression of the valve operating member to the position shown in Fig. 15 the entry of the lower section 23 of such member through the throat 85 causes cut-off of the reservoir chamber 51 from fluid communication with the dip tube 15 and the main body of the substance to be dispensed within the main container while, at a later time instant, lowering the transverse port 25 in the upper section 22 of the valve operating member below the lower edge of the sealing ring 26*b* establishes a discharge communication path from the reservoir chamber 51 through such port 25 and the axial bore 24 of the stem 22 to a discharge orifice located in an attached knob (not shown) in a manner exactly as already described in connection with the earlier embodiments.

The embodiment just described can conveniently be formed largely of material such as plastic which can readily be cleaned and which may be arranged to be inert to either the substance to be dispensed and/or the propellant material incorporated therein. Thus the valve body 14 as a whole may be formed of plastic and also the valve operating member 16 with the sealing ring 26*b* made either of plastic or rubber. Alternatively, the valve operating member 16 may be made of metal such as stainless steel.

To remove the helical spring 34 from within the reservoir chamber 51 where it comes into contact with the substance to be dispensed, use may be made of the alternative construction shown in Fig. 17 where an external spring, in this instance in the form of a bow spring 90, is used and is arranged with each of its two parallel limbs slotted as shown at 91 in Fig. 18, the slot in the upper limb engaging in an annular groove 92 formed around the upper section or stem 22 of the valve operating member 16 and the similar slot in its lower limb being arranged to embrace the tubular flange of the turned-over cap 84. Other spring dispositions and constructions may obviously be used, for instance, the spring may be arranged to embrace the outer part of the stem 22 of the valve operating member as shown in certain of the earlier embodiments and as also shown in Figs. 19 and 20.

The embodiment shown in Fig. 17 also employs a modified and still further simpilfied construction for the valve body 14 in which a thistle tube shaped member 93 of suitable material such as plastic is used as a combined reservoir chamber 51 and dip tube 15, the upper beaded edge 94 of such thistle tube member being itself embedded within a thick rubber or plastic sealing ring 95 which is disposed to lie upon and be held in clamped sealing relationship with the upper surface of the bottle neck by a surrounding rolled-on collar 84*a*. In this embodiment also the lower end of the section 23 of the valve operating member 16 is provided with a number of projecting ribs 96 for entering into sealing contact with the bore of the dip tube portion 15*x*.

Figs. 19 and 20 illustrate a further modification in which use is made of a valve body 14 comprising a rigid, e.g. metal member of tubular form having an outwardly projecting collar 38 at its upper end below which is disposed a suitable screw-thread 13 for engagement with corresponding threads in the neck of the container. The lower tubular portion 97 defines an inner bore 98 of constant diameter except for a constriction 99

near its lowermost end. This bore is adapted to receive in tight-fitting engagement the upper end of the dip tube 15 made of suitable material such as plastic whereby such constriction 99, in addition to assisting in holding the tube 15 in position, also forms one element of a valve structure the other co-operating element of which comprises the enlarged lower end of the valve operating member 16, such end being in the form of a short cylinder 100 terminating downwardly in a frusto-conical region 101.

The valve member 16 has a central section 21 in the form of a cylinder loosely fitting within the upper region of the bore of the dip tube 15 and connected to the enlarged lower end 100 of the lower section 23 by a reduced diameter portion 102. Above the central section 21 the valve operating member extends outwardly by a reduced diameter stem 22 passing through a sealing ring 26*a* of quadrant section held captive on the upper surface of the valve body by a turned-over dome 45. The upper stem 22 of the valve operating member is bored axially downwards at 24 to below transverse port 25 communicating with the outside surface of such upper section in a manner analogous to that already described in earlier embodiments.

The valve operating member 16 is continuously urged upwardly to bring the upper shoulder surface 31 of the central section 21 into sealing engagement with the under surface of the sealing ring 26*a* by means of a helical compression spring 34*a* surrounding the stem and held trapped between the upper region of the turned-over dome 45 and the underside of a retaining ring 54 held in a suitable annular groove around such upper stem.

The operation of this embodiment is again similar to those already described, the normal position of the valve operating member or plunger 16 being that shown in Fig. 19 where the reservoir chamber defined by the upper end of the bore of the dip tube above the constriction 99 is free to be filled with material from the main container by passage through such constricted region and past the lower end 100 of the valve operating member. Upon depression of the valve operating member to its second position as shown in Fig. 20 the enlarged lower end 100 of the said member enters into sealing engagement with the constricted region 99 whereby the upper part of the dip tube 15 forming the reservoir chamber is cut-off from all fluid connection with the rest of the main container. At the same time the port 25 is lowered to below the sealing ring 26*a* whereby the contents of the reservoir chamber can expand and be discharged outwardly by passage through the annular gap between the central section 21 and the inner wall of the dip tube 15 and thence through port 25 and bore 24 to the discharge orifice in the operating knob (not shown).

One modification of the arrangement of Figs. 19 and 20 is shown in Fig. 21 where the valve operating member 16 is made in two parts, the lowermost section 23 being slidable axially within the central section 21 by the formation of an axial cylindrical bore 104 in such central section 21 for receiving the piston-like upper end 105 of the lower section. A helical spring 106 surrounding the reduced diameter portion 102 of such lower section operates normally to urge such lower section downwardly, i.e. out of the central section to an extent limited by the turning-over or crimping of the lower edge 107 of the aforesaid cylindrical bore.

In the operation of this modified arrangement the enlarged lower end 100 of the lower section 23 need only move into sealing contact with the constricted region 99 of the dip tube bore and need not pass therethrough, such enlarged lower end 100 being held in resilient sealing engagement with such constricted region during the continued downward movement of the remainder of the valve operating member by compression of the helical spring 106.

A further modification is illustrated in Fig. 22 where the enlarged lower end 100*a* of the valve operating member 16 of Figs. 19 and 20 is itself made smaller than the smallest diameter of the constricted region of the bore of dip tube 15 and is provided with a separate sealing ring 108 of suitable profile held within an annular groove 109 around such enlarged lower portion.

What I claim is:—

1. A fluid dispensing device for dispensing at each operation thereof, a predetermined metered quantity of a fluid substance from a pressure-tight container which contains a pressure generating medium therein, said device comprising a reservoir chamber for holding said predetermined quantity of fluid substance, a reciprocatory rod-like plunger having a tubular upper section, a central section disposed within said reservoir chamber and a lower section, a resilient ring surrounding said upper section of said plunger and adapted hermetically to seal such upper plunger section to the upper end of said reservoir chamber, a lateral outlet port from the bore to the exterior of said tubular upper section of said plunger, said outlet port being arranged to coact with said resilient ring to form a first valve which becomes closed when said plunger is raised and which becomes opened to provide access from said reservoir chamber to said bore of said tubular upper section of said plunger when the latter is lowered and an inlet port leading to said reservoir chamber, said inlet port being arranged to coact with the lower section of said plunger to form a second valve which becomes opened when the plunger is raised and

which, upon lowering of said plunger, becomes closed to liquid flow therethrough before said first valve is opened.

2. A device according to Claim 1 in which said second valve is constructed to permit continued flow of gas under pressure through said inlet port after its closure to liquid flow.

3. A device according to Claim 1 or 2 in which said plunger is arranged to be resiliently urged upwardly so as normally to close said first valve and to open said second valve and thereby to place said reservoir chamber in fluid communication with the substance within said container.

4. A device according to Claim 3 wherein said tubular upper section of said plunger is arranged to extend outwardly for connection to an external manual operating member which is provided with a discharge orifice.

5. A device according to Claim 4 wherein said plunger is of circular cross-section and is mounted for reciprocatory movement within a circular section bore in a valve body which constitutes said reservoir chamber.

6. A device according to any of the preceding claims wherein said inlet port is in a rigid side wall of said reservoir chamber and wherein said lower section of said plunger is provided with a resilient sealing ring or rings for co-operation with said rigid walled port.

7. A device according to any of the preceding Claims 1—5 wherein said inlet port is in a resilient side wall of said reservoir chamber and wherein said lower section of said plunger comprises a rigid part for co-operation with said resilient walled port.

8. A device according to any of the preceding claims wherein said inlet port comprises an opening coaxial with the axis of reciprocation of said plunger and said lower section of said plunger comprises a plug element for said opening.

9. A device according to Claims 2 and 8 wherein said lower section of said plunger is in the form of a plurality of coaxial cylinders of progressively decreasing diameter, one of said cylinders being of larger diameter than that of said port opening and an adjacent cylinder being of a diameter very slightly less than that of said port opening.

10. A device according to Claim 8 in which said plug element is formed upon a member separate from but slidable in said plunger.

11. A device according to Claim 10 which includes spring means for resiliently urging said plug element towards said port opening and stop means for limiting the extent of such resilient movement.

12. A device according to Claim 3 or any claim dependent thereon in which spring means for urging said plunger upwardly is disposed in said reservoir chamber.

13. A device according to any of the preceding claims in which said reservoir chamber and said plunger are formed of plastic or other chemically inert material.

14. A device for dispensing substances comprising a pressure-generating medium comprises the combination of a pressure-tight container and a fluid dispensing device according to any of the preceding claims mounted in sealed manner in a wall of said container.

15. A fluid dispensing device substantially as described with reference to Figs. 2 and 3, Fig. 4, Fig. 5, Fig. 6, Fig. 7, Fig. 8, Figs. 9—11, Fig. 12, Fig. 13, Figs. 14 and 15, Figs. 17 and 18, Figs. 19 and 20, Fig. 21 or Fig. 22 of the accompanying drawings.

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Agents for the Applicant.

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SHEET 1

FIG. 1

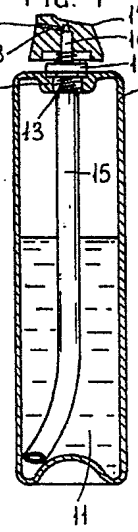


FIG. 2.

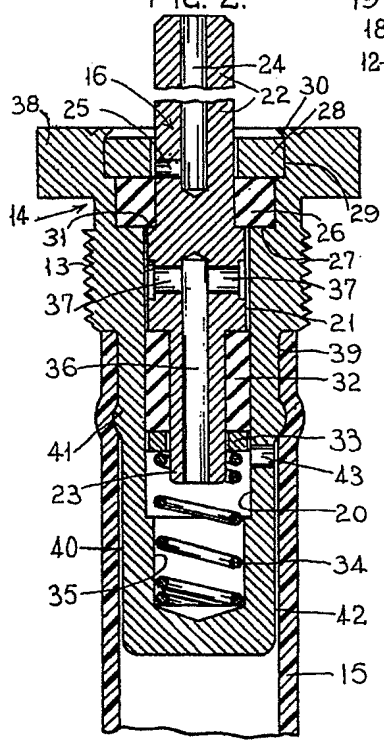


FIG. 3.

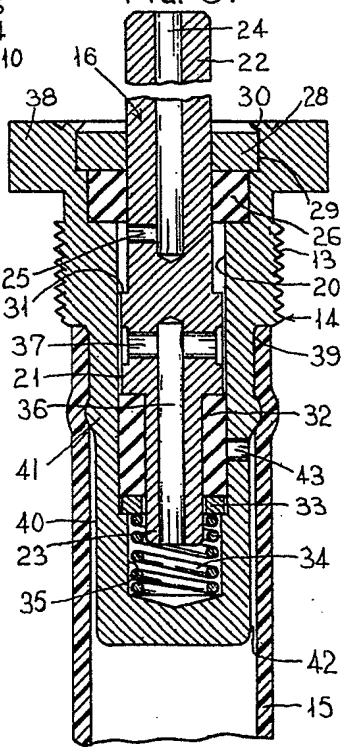
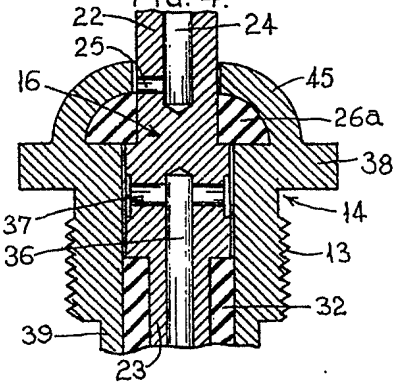


FIG. 4.



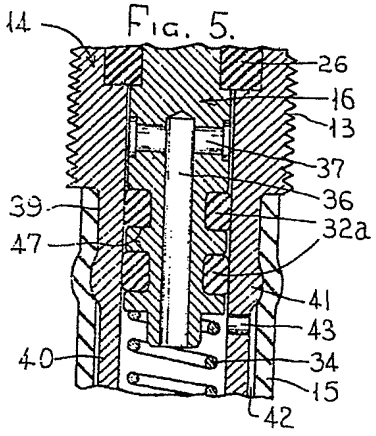


Fig. 5.

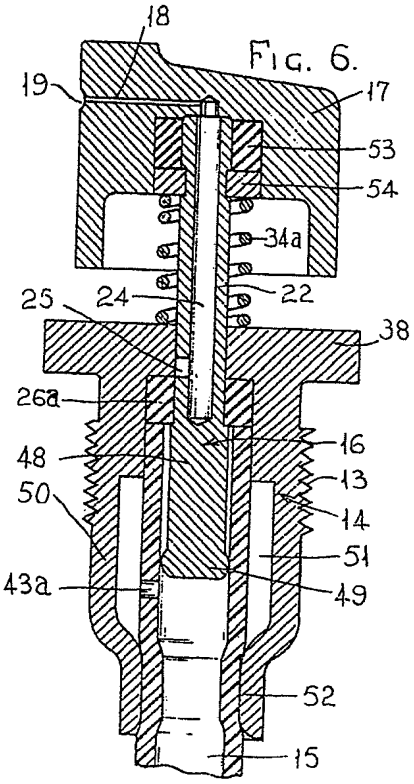


Fig. 6.

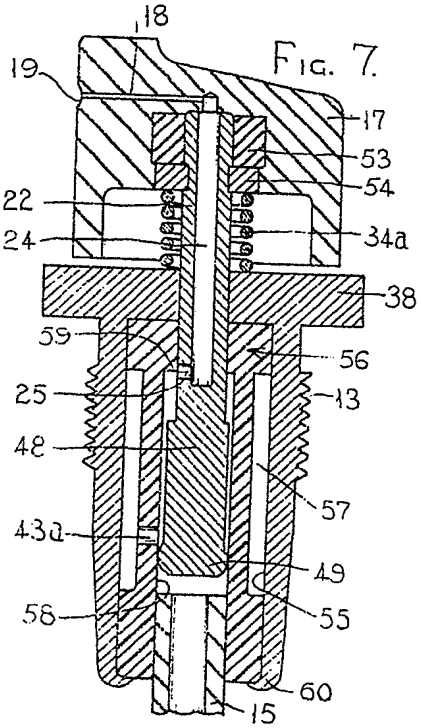


Fig. 7.

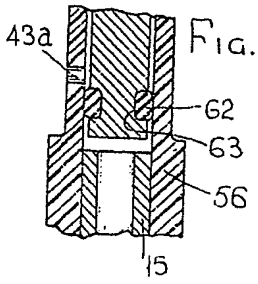


Fig. 8.

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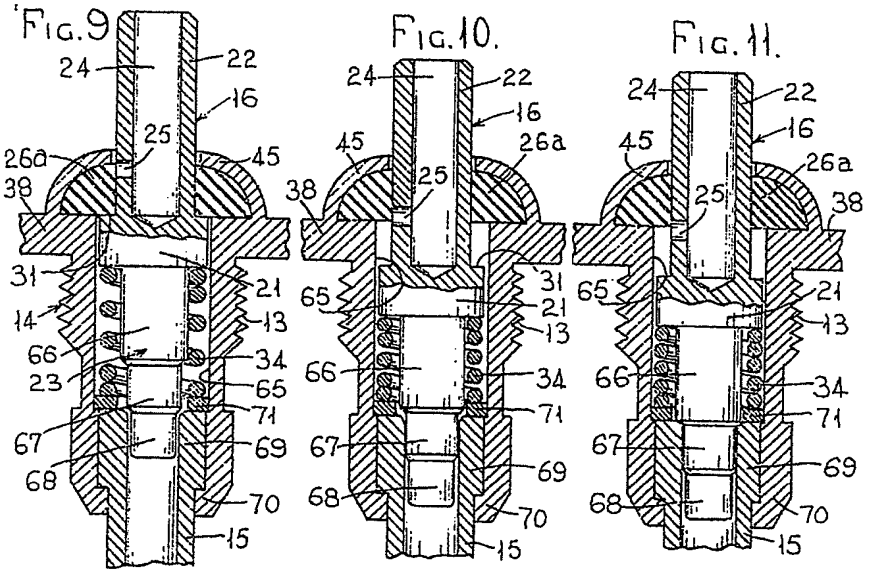
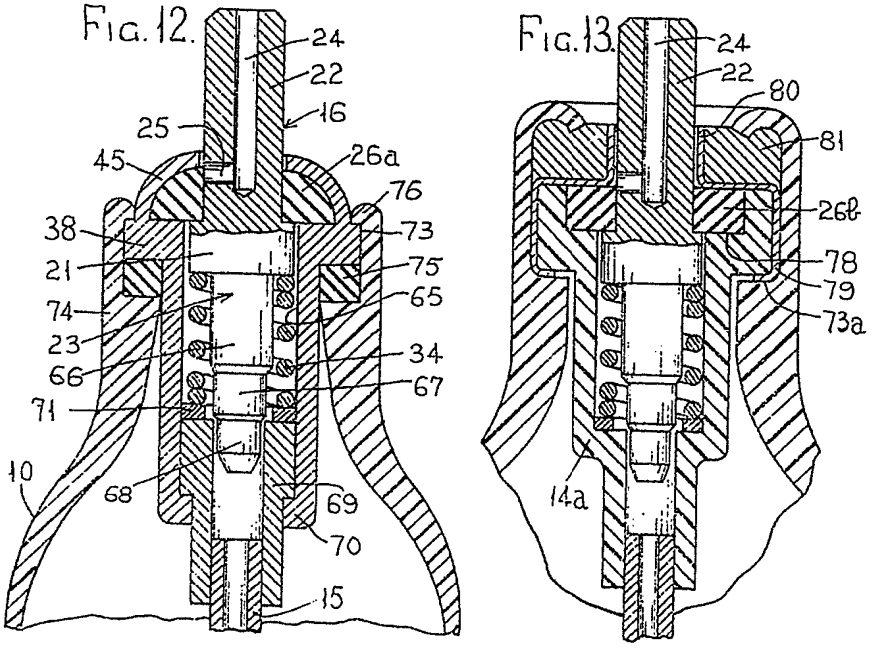
SHEETS 2 & 3





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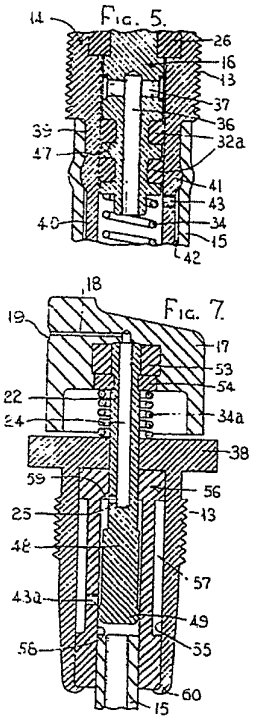
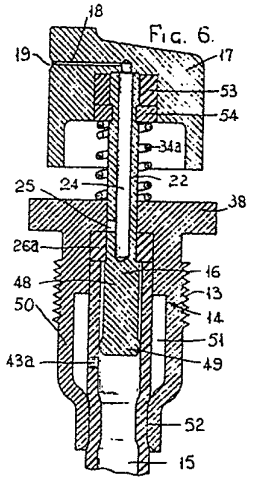
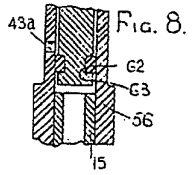
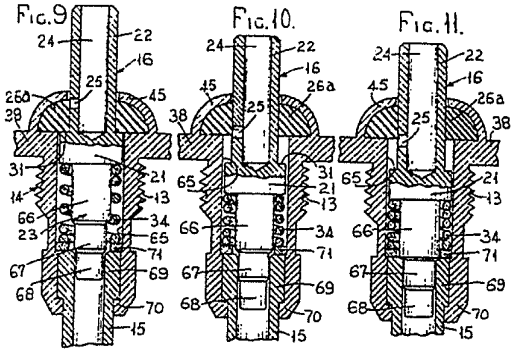
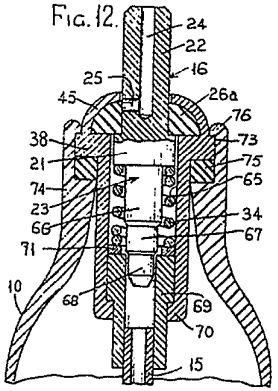
SHEETS 2 & 3











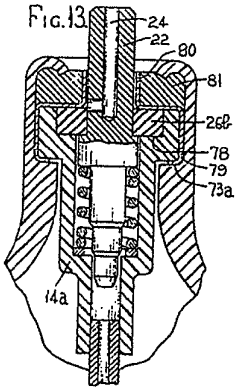


Fig. 17.

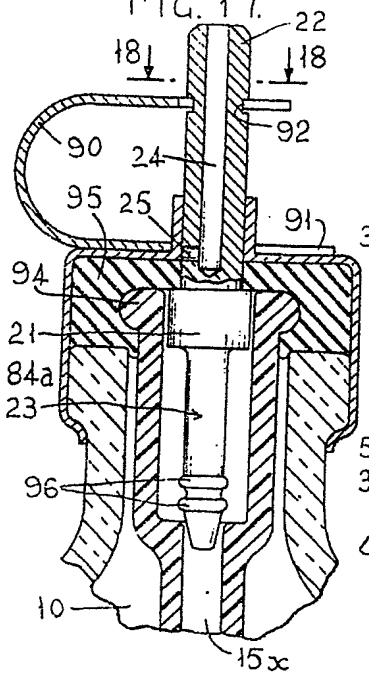


Fig. 14.

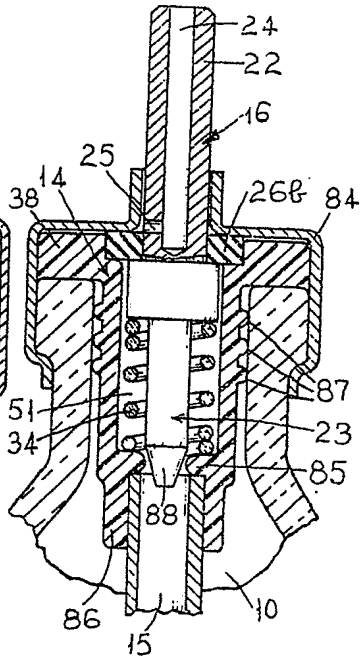


Fig. 15.

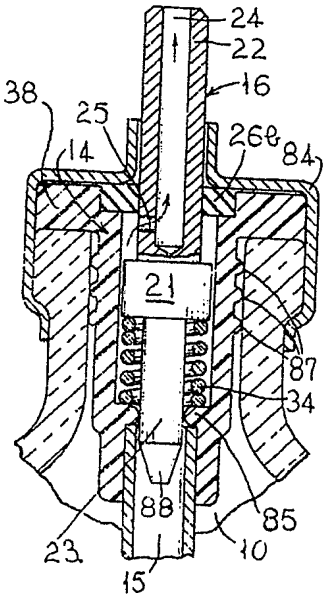


Fig. 16.

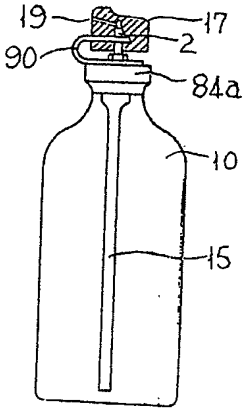
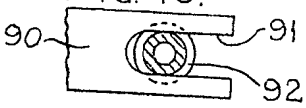
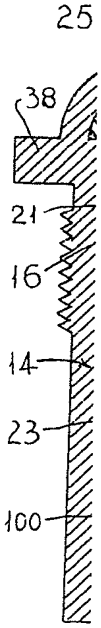


Fig. 18.





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SHEETS 4 & 5

FIG. 19

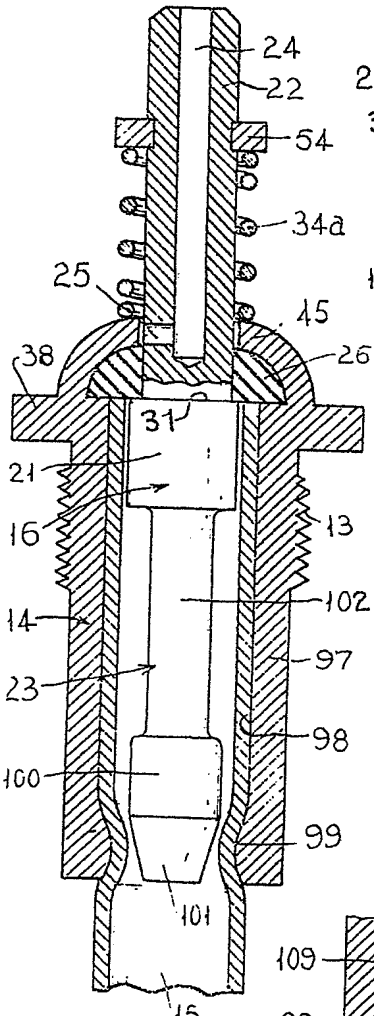

FIG. 21.

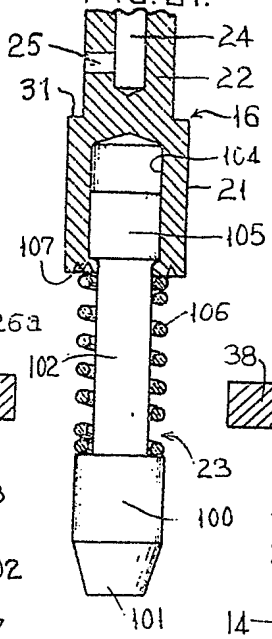

FIG. 20.

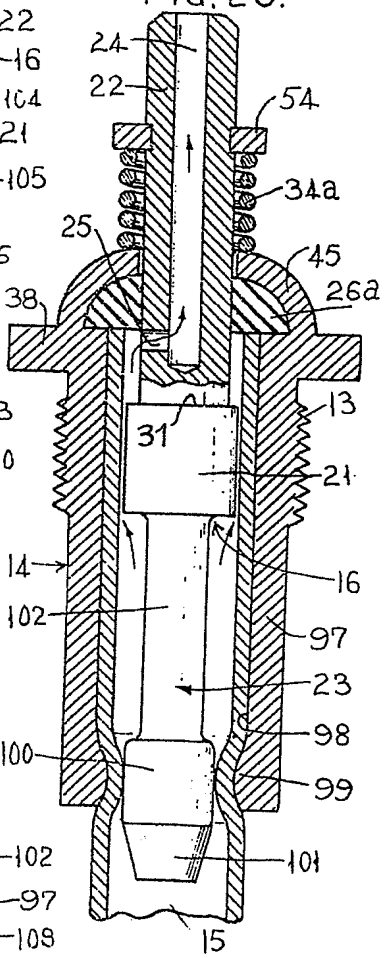

FIG. 22.

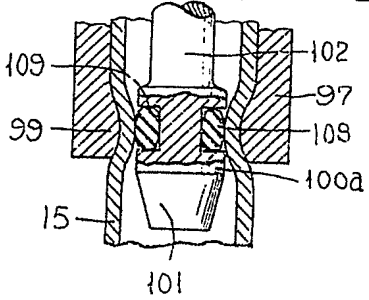

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Fig. 17.

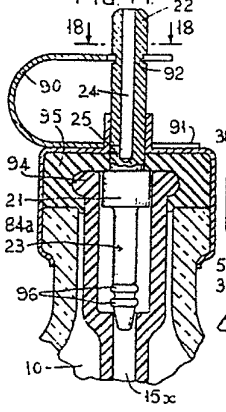

Fig. 14.

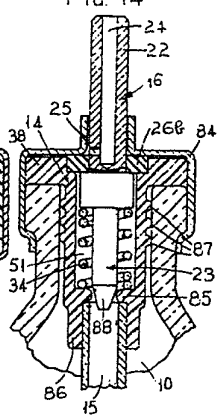

Fig. 15.

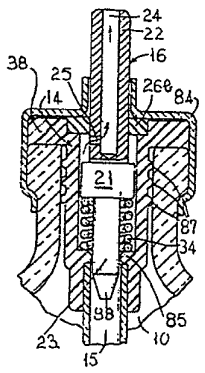

Fig. 16.

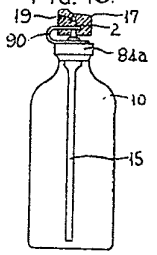

Fig. 18.

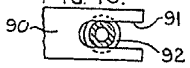

Fig. 19.

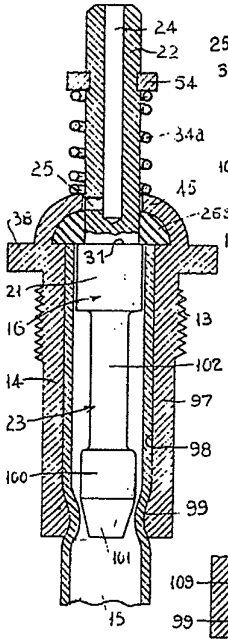

Fig. 21.

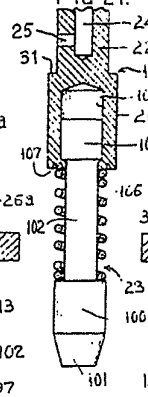

Fig. 20.

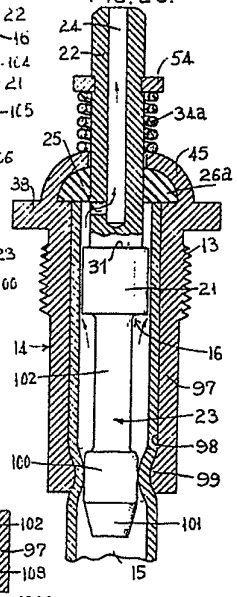

Fig. 22.